STANDARD APPLICATION PROCEDURE FOR (MAPS) MONITOR AND POWER SYSTEMS ACCEPTANCE ACTIONS

U.S. Department of Labor
Mine Safety and Health Administration
Approval and Certification Center

ASAP2018

1.0 PURPOSE

This publication is intended to aid manufacturers, mine operators or their representatives applying for acceptance of Monitor and Power System (MAPS) installation schemes with the Mine Safety and Health Administration's (MSHA's) Approval and Certification Center (A&CC).

2.0 SCOPE

The MAPS acceptance program applies to mine operators that need to install MSHA accepted ground wire monitor(s) in a manner that is not approved in the monitor manufacturer's original acceptance. As a result of being a modification of a Manufacturer's original installation documents, Extensions of Acceptance or other modifications to applications will not be accepted under the MAPS Program. MAPS acceptances will be issued only to parties exhibiting control over the installation.

3.0 REFERENCE

3.1 STANDARD EVALUATION PROCEDURE FOR MONITOR AND POWER SYSTEMS (MAPS) ACCEPTANCES CDS # ASOP 4003.

3.2 STANDARD TEST PROCEDURE FOR ACCEPTANCE OF GROUND WIRE MONITOR SYSTEMS CDS # ASTP4005.

4.0 DEFINITIONS

4.1 Grounding Circuit Drawing - A required MAPS drawing that depicts the complete grounding circuit and the location of all ground wire monitor system components installed in an electrical power system.

4.2 MAPS Installation Test - A test sequence conducted by the MAPS applicant or MSHA to determine if a ground wire monitor (GWM) installation will perform in a manner acceptable to MSHA according to 30 CFR Parts 75.524, 75.803, 75.902, 77.803, 77.902, 18.47(d)(2), and 18.50(b). An hourly rate fee will be charged for all tests conducted by MSHA.

4.3 Sectionalized Circuit - A circuit whose grounding conductor connects to three or more metal frames. (Example: A trailing cable or longwall cable

containing grounded in-line cable couplers or connection boxes).

4.4 Non-Sectionalized Circuit - A circuit whose grounding conductor connects to only two metal frames, not including insulated metal frames. (Example: A trailing cable containing no grounded in-line cable couplers or connection boxes or a trailing cable containing grounded in-line cable couplers or connection boxes that have been insulated or isolated from contact with the earth and all equipment frames).

4.5 Multiple Sectionalized Circuits - Two or more sectionalized circuits originating at the same power center, controller, or switch house.

4.6 GWM Trip Resistance - A resistance used by MSHA during the fail-safe testing of a ground wire monitor according to criteria established under Title 30 Code of Federal Regulations, Parts 75.524, 75.803, 75.902, 77.803, 77.902, 18.47(d)(2), and 18.50(b).

4.7 MAPS Applicant - Parties or their representatives applying for acceptance of Monitor and Power Systems installations.

4.8 Pre-authorization Notice - A statement by the applicant authorizing MSHA to expend a stated amount of money in evaluating/testing the applicant's product prior to the preparation, issuance, and return of the MSHA fee estimate.

5.0 GENERAL

5.1 Applicants applying for testing, evaluation, and approval of products manufactured for use in underground mines may submit with their applications a pre-authorization notice authorizing MSHA to expend a stated amount of money in evaluating or testing the applicant's product prior to the preparation, issuance, and return of the MSHA fee estimate. The A&CC will provide an estimate of the total anticipated charges and continue with processing or cancel the action depending upon the applicant's response to the fee estimate letter. If the applicant chooses to cancel, fees will be charged for work performed up to receipt of the cancellation request. If total charges are less than the pre-authorization amount, the lesser amount will be charged.

5.2 The information submitted to MSHA by MAPS applicants, will be evaluated in accordance with the acceptance criteria included as Appendix No. 1. When the submitted information meets these acceptance criteria, a MAPS acceptance number will be issued by MSHA for the specific monitor and power system installation. A MAPS label with the MSHA Acceptance Number must be displayed on the power center or substation of the power system as near as practical to the circuit outlet that is described by the information submitted in the MAPS application.

5.3 The ground wire monitors and ground wire devices utilized in MAPS applications must have been previously accepted by the MSHA.

5.4 Should assistance be required in completing the application form, contact the A&CC, Electrical Equipment Branch prior to actual submission of the application.

6.0 MAPS Documentation Required

6.1 Applicants must identify all documents that will be distributed to users of the MAPS Acceptance. The distributed documents must be sufficient to enable the user to install and maintain the MAPS Acceptance and include a MAPS Acceptance Label for each circuit in the MAPS System.

6.2 A completed MAPS acceptance and application form, Appendix No. 2, completed in accordance with Section 8.0 of this document.

6.3 A Grounding Circuit Drawing that depicts the complete grounding circuit, all circuit components, and the location of all ground wire monitor system components installed in the electrical power system. If the circuit is typical of all other circuits in the system, only one representation of the circuit is necessary when the total number of circuits is identified.

6.4 Test results corresponding to Figures 1 through 6 of the “Ground Wire Monitor and Ground Wire Device Installation Test” completed in accordance with Section 7.2 of this document and recorded on Appendix No. 3, if applicable.

6.5 A “Ground Fault Current Analysis”, completed in accordance with Section 7.4 of this document.

6.6 A MAPS Acceptance Label must be manufactured and one copy of the label returned to the A&CC prior to the acceptance letter being issued to the applicant.

6.7 MSHA reserves the right to require the submittal of additional information for the issuance of a MAPS acceptance.

7.0 MAPS TEST AND ANALYSIS

The MAPS Program categorizes mine electrical power systems into configurations based on the available ground fault current and whether sectionalized circuits are used. The applicant should review his proposed MAPS installation and power system and determine which configuration matches his installation.

All tests and analyses must be conducted by the applicant, documented, and given test identification numbers. Each test identification number shall begin with the first three letters of the company name, followed by the letters “MAPS,” a dash (**-**), and a sequential number assigned by the applicant. For example, the DLM Company test numbering sequence would be DLMMAPS-1, DLMMAPS-2, etc.

If an installation has been previously evaluated by the applicant and the test data is on file at MSHA, the applicant may reference the test number on the MAPS application without resubmitting data.

7.1 Configurations using non-sectionalized circuits for all circuits of the power system requires an analysis of the GWD’s short circuit current capabilities.

7.2 Ground Wire Monitor Drop Out Resistance Test Procedure

This test procedure is for configurations using sectionalized circuits and provides documentation of a ground wire monitor’s maximum drop out resistance. Results of tests conducted under this section are recorded on the “Ground Wire Monitor and Ground Wire Device Installation Test Data Sheet,” Appendix No. 3. The sequence of testing must be followed exactly to successfully produce reliable results.

7.2.1 The equipment required for this test is two complete ground wire

monitor systems (this includes ground wire devices and peripheral components), four 0.3 O resistors, one 100 O ten turn potentiometer, six test leads, one volt-ohm meter, twelve 0.25 O resistors for pilot-wireless installation testing, and four 1.5 O resistors for pilot wire installation testing.

7.2.2 Connect two ground wire monitor systems in circuit configurations described by Figure 1 for pilot wire installations, or Figure 2 for pilot-wireless installations. Note that parallel paths are not installed during this test. Label the figure with the model numbers of the ground wire monitor and all peripheral components at the locations of the components. All ground wire devices must be installed in accordance with the manufacturer's instructions. Ground wire devices are not permitted to be installed inside cable couplers.

7.2.3 Calibrate only those monitors with front panel controls in accordance with the manufacturers' instructions.

7.2.4 Adjust a 100 ohm potentiometer to zero ohms and install the potentiometer in GND 10.

7.2.5 Increase the resistance of potentiometer until the control relay on Monitor No.1 just trips.

7.2.6 Remove the potentiometer and reconnect GND 10. Measure the potentiometer's resistance and record it on data sheet 1 for "GWM 1."

7.2.7 Repeat steps 7.2.4, 7.2.5, and 7.2.6 for GND 11.

7.2.8 Adjust the 100 ohm potentiometer to zero ohms and install it in GND 20.

7.2.9 Increase the resistance of potentiometer until the control relay on Monitor No. 2 just trips.

7.2.10 Remove the potentiometer and reconnect GND 20. Measure the potentiometer's resistance and record it on data sheet 1 for "GWM 2."

7.2.11 Repeat steps 7.2.8, 7.2.9, and 7.2.10 for GND 21.

7.2.12 The measured resistance of the potentiometer in Sections 7.2.6, 7.2.7, 7.2.10, or 7.2.11 cannot be greater than 50 ohms. If the monitor fails to trip at 50 ohms or less at any time, the system cannot be used in a MAPS installation.

7.3 Open Ground Wire Test

This test verifies the GWM's effectiveness at monitoring the continuity of the ground wire. Results of tests conducted under this section are recorded on Appendix No. 3, "Ground Wire Monitor and Ground Wire Device Installation Test Data Sheet," under Open Ground WireTest.

7.3.1 Monitors of different manufacturers and model numbers must be tested to insure that all possible combinations of manufacturers and model numbers are tested even if the test circuit must be expanded to include more than two ground wire monitors. At least two (2) ciruits must be installed and operating during the testing sequence.

7.3.2 Install two ground wire monitors in accordance with Figure 3 or Figure 4 connecting parallel paths PP10, PP11, PP20, PP21, PPMF, and PPCF.

7.3.3 Open GND 10 and record response for both GWM's under Data Sheet 2 section.

7.3.4 Reclose GND 10.

7.3.5 Open GND 11 and record response for both GWM's under Data Sheet 2 section.

7.3.6 Reclose GND 11.

7.3.7 Open GND 20 and record response for both GWM's under Data Sheet 2 section.

7.3.8 Reclose GND 20.

7.3.9 Open GND 21 and record response for both GWM's under Data Sheet 2 section.

7.3.10 Reclose GND 21.

7.3.11 Monitor(s) that tripped when both sections of their associated cable GND wires were opened, GND 10 and 11 for monitor 1 and GND 20 and 21 for monitor 2, exclusively monitor the ground wire for continuty. If monitor 1 and monitor 2 failed to trip when either section of their associated cable GND wire was opened, this ground wire monitor must be evaluated to simulate an impedance type ground wire monitor or the application fails.

7.4 Ground Fault Current Analysis

This test procedure is for all installation configurations and all types of ground wire monitors.

7.4.1 Measure the value of the neutral grounding resistor in ohms (R_{NGR}).

7.4.2 Add the total of all resistances that can appear external to the neutral grounding resistor. This includes the dropout resistance of the ground wire monitor, ground conductor resistance, etc. A trip resistance of 50 ohms is used for all continuity ground wire monitors in this calculation. If the cable length exceeds 1000 feet, the resistance of the cable ground conductor must be included in the total grounding circuit resistance. The trip resistance for impedance ground wire monitors can be obtained from the original acceptance records.

7.4.3 The sum of all resistances that can appear external to the neutral grounding resistor must be less than the value of the neutral grounding resistor. This ensures that the ground fault current will always be greater than one-half of the total available.

7.4.4 The restricted ground fault current must be greater than 40 percent of the available current based on the ohmic value of the neutral grounding resistor.

7.5 Frame Voltage Calculation

The saturation voltage of ground wire devices installed for intermachine arcing or parallel path isolation purposes will add a voltage to the total voltage developed across the grounding conductor during grounded phase conditions. This voltage is determined based on the maximum available ground fault current and can be obtained from A&CC records.

7.5.1 Draw a One-Line diagram of the grounding circuit as described in Appendix No. 4. Begin at the source transformer where the neutral grounding resistor is installed and proceed to the farthest point of the system. Include the source transformer, the neutral grounding resistor, all ground wire devices, and a dropout resistance for each ground wire monitor installed. If the cable length exceeds 1000 feet, the resistance of the cable ground conductor must be included in the total grounding circuit resistance.

7.5.2 Obtain the saturation voltage for each ground wire device installed in the grounding circuit.

7.5.3 Calculate the potential voltage that can appear on the machine frame. Appendix No. 5 shows sample formulae and Figures 5 and 6 are examples.

7.5.4 If the calculated voltage exceeds 40 volts, this arrangement cannot be used as a MAPS circuit.

8.0 Instructions For Completing The MAPS Acceptance and Application Form

Enter the following information on the appropriate line of the application form:

8.1 The name and address of the company applying for the MAPS Acceptance.

8.2 The name of company official that all correspondence is to be addressed.

8.3 A company assigned application code number. This is a numerical code (up to six digits) assigned by the applicant for identification purposes. **Note that this number cannot be duplicated in future applications.**

8.4 The grounding circuit drawing numbers. The revision level of each drawing must be included. If the drawing has no revision level, designate this by placing a dash (**-**) in the revision block.

8.5 The identification number of the GWM/GWD installation test or tests that show the GWM's, GWD's, and all combination of GWM's and GWD's, that are requested in the installation.

8.6 The maximum phase-to-phase short circuit current at the power center's receptacle. This calculation must be made for each voltage supplied by the power center. Tabulate the current and voltage on the application form (i.e. current @ voltage).

8.7 The maximum clearing time beginning at the inception of short circuit current until a protective device de-energizes the power circuit. Tabulate the current and clearing time on the application form (i.e. current @ time).

8.8 A company official’s printed name and title, the company name, and the written signature of the person responsible for the MAPS application.

9.0 MAPS ACCEPTANCE LABEL DESIGN

9.1 A MAPS acceptance label must be affixed to the power center, etc. in a visible location as near as practical to the circuit outlet discribed by the Acceptance (affixed to the circuit plug or receptacle is also acceptable). The label may be made of a self-adhesive foil type material .

9.2 When the electrical installation changes or the power center is modified, the MAPS label must be removed (or destroyed if not removable). When the MAPS is reinstalled at another location, another label must be installed at that location to identify the MAPS circuit.

9.3 A sample label design is included in this section. The label must include at least the following information:

9.3.1 MSHA Logotype.

9.3.2 Space for MSHA MAPS Acceptance Number.

9.3.3 Space for a narrative description of the ground wire monitors and related system components of the monitoring system.

9.3.4 The sample follows:

UNITED STATES DEPARTMENT OF LABOR

MSHA

MINE SAFETY AND HEALTH ADMINISTRATION

MAPS APPLICANT COMPANY
MONITOR AND POWER SYSTEM ACCEPTANCE

MAPS-01010101

Power Center Requirements
Nominal System Secondary Voltage = 2400 volts
Maximum Short Circuit Current = 16,000 Amperes
Maximum Circuit Interrupt Time = 0.30 Seconds
Maximum Ground Fault Current = 0.500 Amperes
Maximum Ground Fault Trip Setting = 0.125 Amperes

Continuous Mining Machine Requirements
Trailing Cable May Include
MSHA Certified In-Line Connection Boxes or
MSHA Certified In-Line Cable Couplers

Ground Wire Monitor Requirements
Ground Wire Monitor Corporation
MSHA Acceptance No: 010101GM-001
Pilot Wire Device: 01-0101-01, or A0101-001
Ground Wire Device: B-MSHA-1, or B-MSHA-2

10.0 Responsibility

A&CC investigators, MAPS applicants, or their representatives shall assure that ground wire monitors and related peripheral components meet the criteria detailed in this document.

11.0 Notification

Applicants will be notified when an installation is accepted under the MAPS program and an acceptance number is issued.

12.0 Distribution

This document can be distributed to interested parties upon request.

13.0 Results

The result of the procedures detailed in this document provides application guidelines and acceptance criteria to manufacturers, mine operators or their representatives applying for a MAPS acceptance.

14.0 Review

This document will be reviewed at least once every three years.

15.0 Authority

Title 30 Code of Federal Regulations, Sections 18.47(d)(2), 18.50(b), 75.524, 75.902, 75.803, 77.902 and 77.803.

APPENDIX No. 1

MAPS Program Acceptance Criteria

1. The sum of all voltage drops developed in a single circuit from the occurrence of ground wire monitor drop out resistances, GWDS, circuit detection components, etc., shall not exceed 40 volts.

2. When the cable rating size of a GWD is smaller than the size cable used or where the nominal system voltage exceeds the voltage rating of the GWD, the magnitude of system phase-to-phase short circuit current calculated at the power center receptacle and the maximum short circuit clearing time shall not exceed the values at which the GWD was subjected during MSHA acceptance testing.

4. Low and medium voltage rated GWMs must be equipped with adequate transient protection provided at the pilot and ground wire terminals of the GWM to be used on high voltage systems.

5. The restricted ground fault current must be equal to or greater than 40 percent of the current rating of the neutral grounding resistor.

APPENDIX No. 2

APPROVAL AND CERTIFICATION CENTER
MONITOR AND POWER SYSTEMS (MAPS)
ACCEPTANCE AND APPLICATION FORM

Applicant: _____

Attn: _____

Address: _____

_____

_____

_____

FOR OFFICIAL USE ONLY

ACCEPTED

Date: _____

MAPS -_____

_____

Division of Electrical Safety

Date: _____

Phone: _____

Application Code: _____

Grounding Circuit Drawing Nos. (Include Revision Levels): _____

_____

Installation Test Identification Numbers: _____

_____

Phase to Phase Short Circuit Current at Output Receptacle for Each Voltage Level: _____

_____

Total Circuit Breaker Clearing Time for Each Short Circuit Current: _____

_____

_____, _____ attest that
(Printed Name) (Title)

_____ will maintain records traceable to
(Company)

each MAPS acceptance issued to our company to insure that each MAPS installation meets all MSHA Regulations and safety requirements.

_____ _____
(Written Signature) (Date)

APPENDIX No. 3

Ground Wire Monitor and Ground Wire Device Installation Test Data Sheet

Data Sheet 1; Monitor's trip Resistance:

	GWM dropout resistance (ohms)
GWM 1	_____
GWM 2	_____

Data Sheet 2; Open Ground Wire Test:

	Monitor Response		
	Open GND 10	Open GND 11	
GWM 1	_____	_____	Record "T" when control relay trips.
GWM 2	_____	_____	Record "NT" when control relay does not trip.
	Open GND 20	Open GND 21	
GWM 1	_____	_____	
GWM 2	_____	_____	

Company Official _____ Date _____

GWM/GWD Installation Test Identification Number _____

APPENDIX No. 4

A Grounding Circuit Drawing must contain at least the following information:

1. A representation of each electrical enclosure containing one or more ground wire monitors.

2. The representation of each cable exiting each electrical enclosure.

3. A representation of all in-line cable couplers, dirtribution boxes, connection boxes, and machines monitored.

4. The size (AWG) and length of each cable exiting each electrical enclosure.

5. The acceptance numbers of all ground wire monitors, model and part numbers of all peripherally located ground wire monitor components, and model and part numbers of all ground wire devices for each circuit included in the MAPS system.

6. The location of all ground wire monitors, their peripherally located components, and ground wire devices.

7. The nominal phase-to-phase voltage supplied to each cable exiting each electrical enclosure.

8. The maximum short circuit current available at the output receptacle for each receptacle, if different.

9. The total circuit clearing time for the maximum short circuit current of each circuit interrupter, if different.

10. The ohmic value and percent tolerance of the neutral grounding resistor(s) installed in the MAPS circuit(s).

11. The maximum available system ground fault current.

12. The maximum trip setting of the ground fault tripping relay.

13. The identification of all receptacles associated with each cable.

14. The statement "DO NOT CHANGE WITHOUT MSHA APPROVAL".

15. Title, drawing number, sheet number (if a multiple sheet drawing, e.g. sheet 1 of 2), date, and latest revision level must be placed on each drawing.

NOTE: Only one representation of a redundant circuit needs to be included on the drawing if a notation is made specifying the exact quantity of the redundant circuits.

Appendix No. 5

An example:

1. Construct a one-line drawing the circuit for the MAPS application. A sample drawing is shown in Figure No. 5.

2. Draw a schematic diagram of the grounding circuit; Figure No. 6 is a schematic diagram of the sample drawing in Figure No. 5. Begin at the source transformer where the neutral grounding resistor is installed and proceed to the farthest point of the system. Include the source transformer, the neutral grounding resistor, the resistance of the grounding conductor, a dropout resistance for each ground wire monitor installed, and all ground wire devices.

3. Calculate the potential voltage that can appear on the machine frame. Descriptively the frame voltage that a miner can potentially be exposed is the sum of the voltage drops across the resistance of grounding conductor No. 1 (R_{g1}), the dropout resistance of ground wire monitor No. 1 (R_{do1}), the resistance of grounding conductor No. 2 (R_{g2}), and the dropout resistance of ground wire monitor No. 2 (R_{do2}), plus the saturation voltage of ground wire devices No. 1 (V_{sat1}) and No. 2 (V_{sat2}).

Calculations:

$$V_{frame} = V_{f\ -\ n}\ ((\ R_{g1} + R_{do1} + R_{g2} + R_{do2}\ ) \div (R_{ngr} + R_{g1} + R_{do1} + R_{g2} + R_{do2})) + V_{sat1} + V_{sat2}$$

The typical resistance of a grounding conductor in a longwall power cable is approximately 0.5 ohms, the dropout resistance of a continuity ground wire monitor is 50 ohms, the resistance of a neutral grounding resistor on a 4160 volt, ½ ampere grounded system is 4800 ohms, and the saturation voltage of a National Mine Service Company (Femco) GM1004 ground wire device at ½ ampere is 0.3 volts. So

$R_{g1} = R_{g2} = 0.5$ O,

$R_{do1} = R_{do2} = 50$ O, and

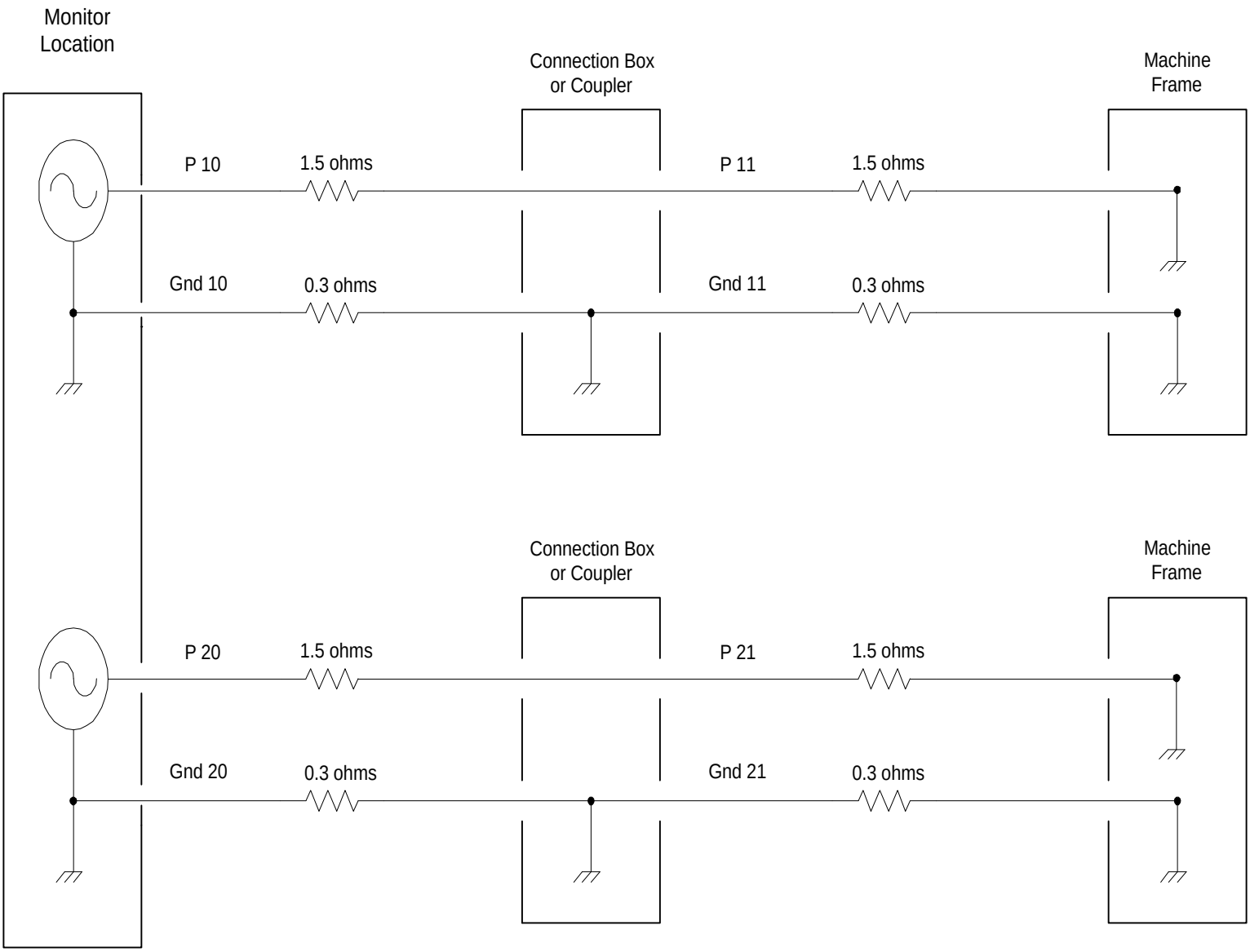
$V_{sat1} = V_{sat2} = 0.3$ volts.

If we substitute these values into our equation, we have

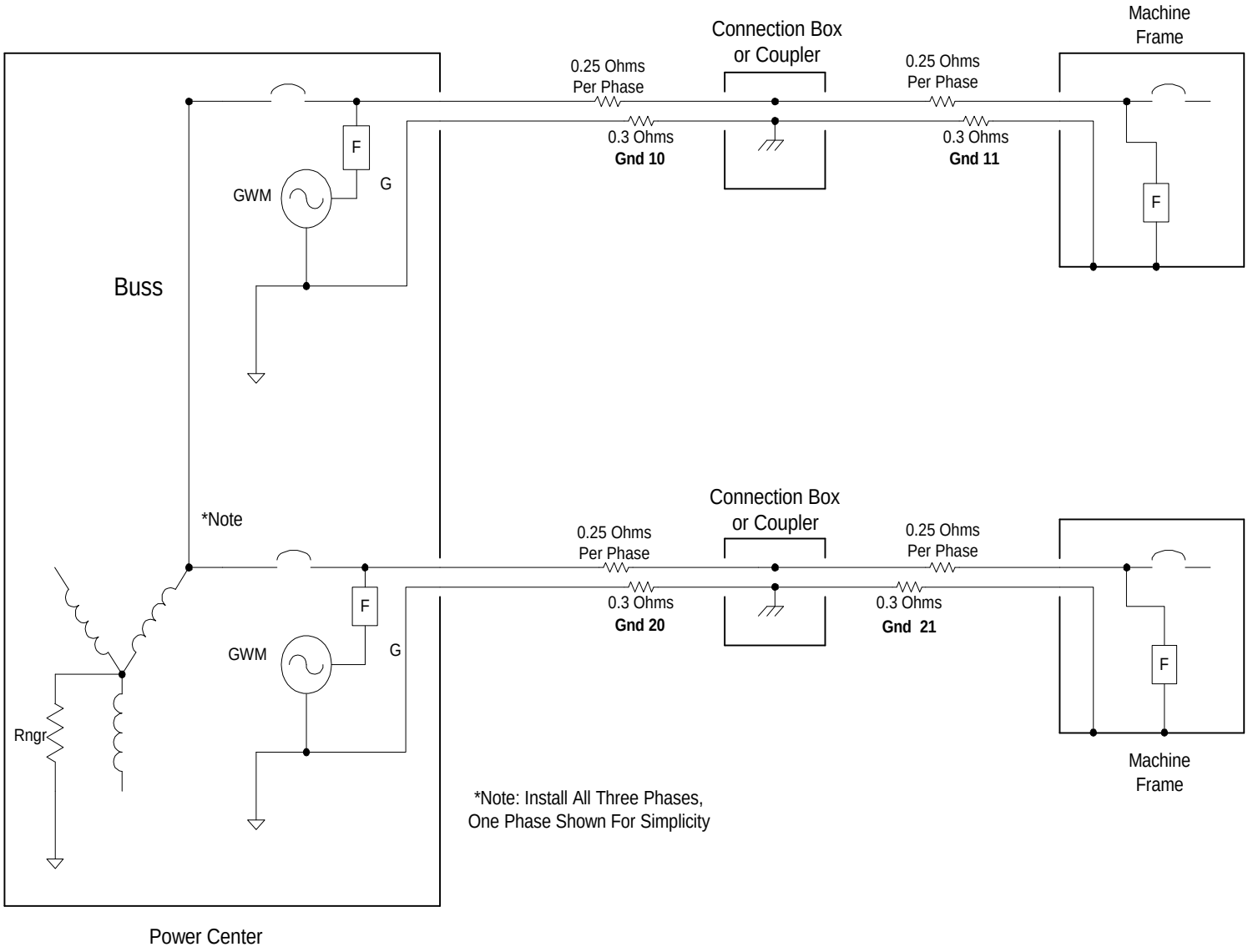
$$V_{frame} = 2400((0.5 + 50 + 0.5 + 50) \div (4800 + 0.5 + 50 + 0.5 + 50)) + 0.3 + 0.3 \text{ volts}$$

$V_{frame} = 50$ volts.

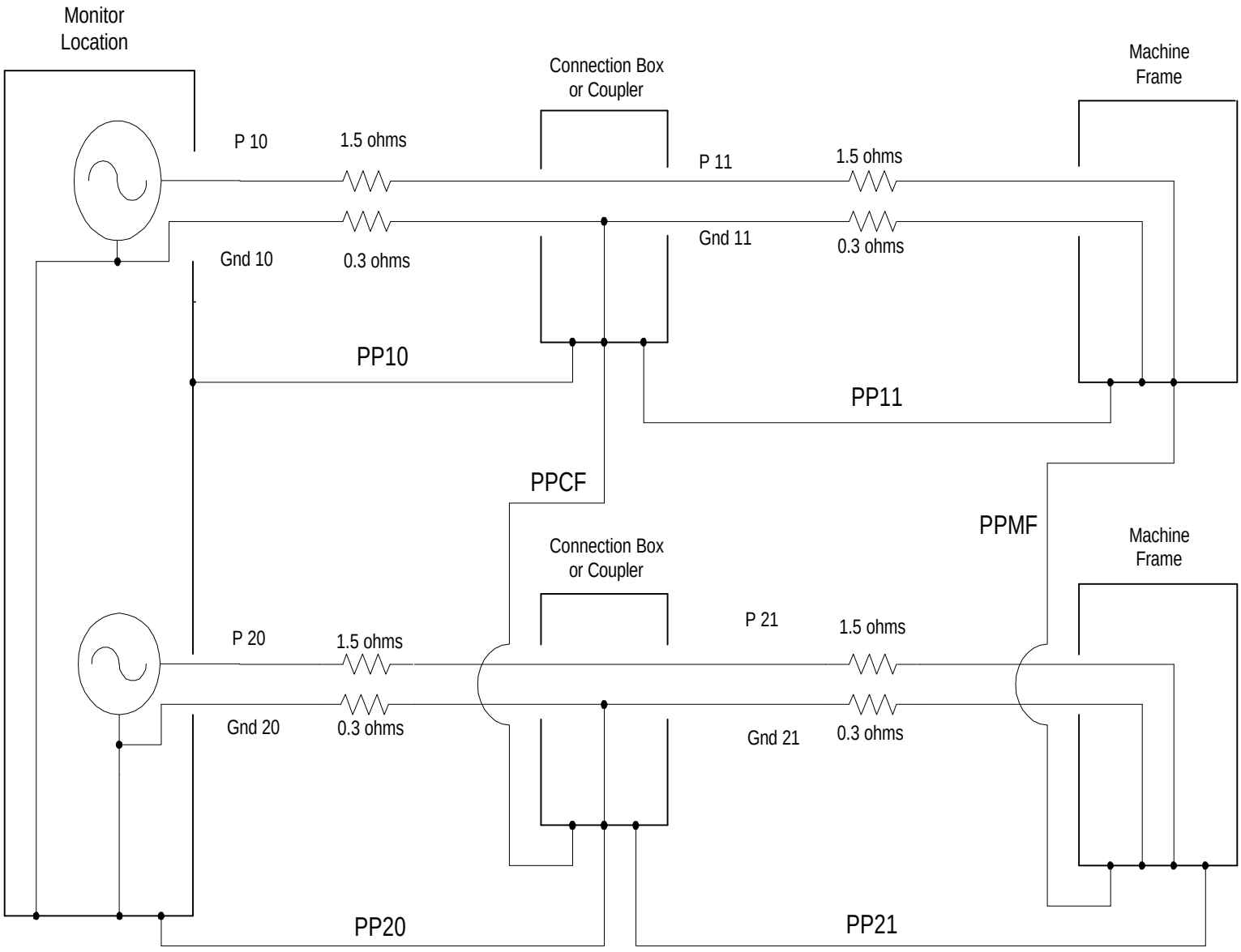
Since this value exceeds the limits set forth in 30CFR 18.50(b) or 40 volts, this circuit does not meet the requirements of the MAPS program. Modifications to the circuit are required so that the frame voltage does not exceed 40 volts.



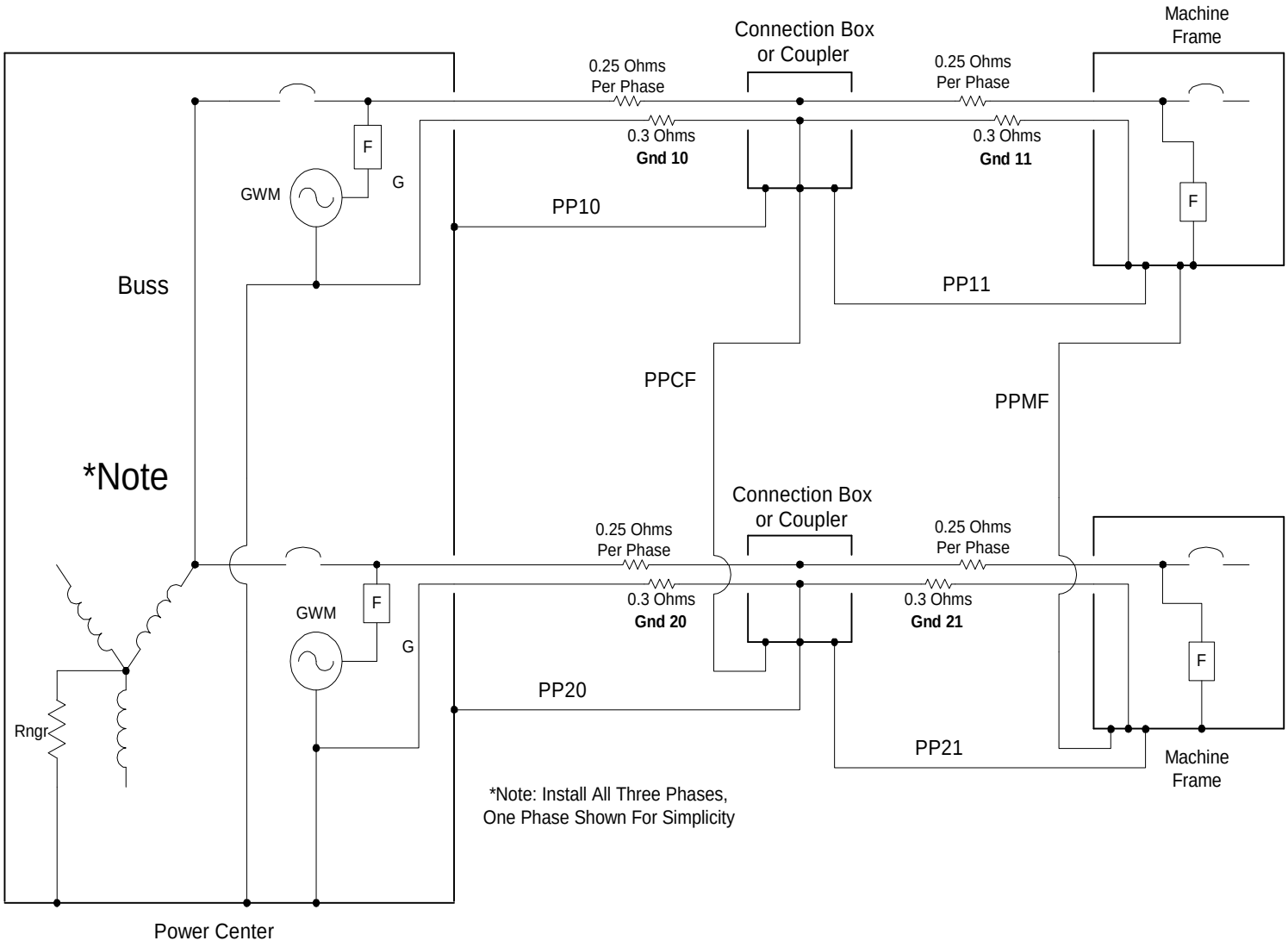
Pilot Wire Installation
Without Parallel Paths Shown
Figure No. 1



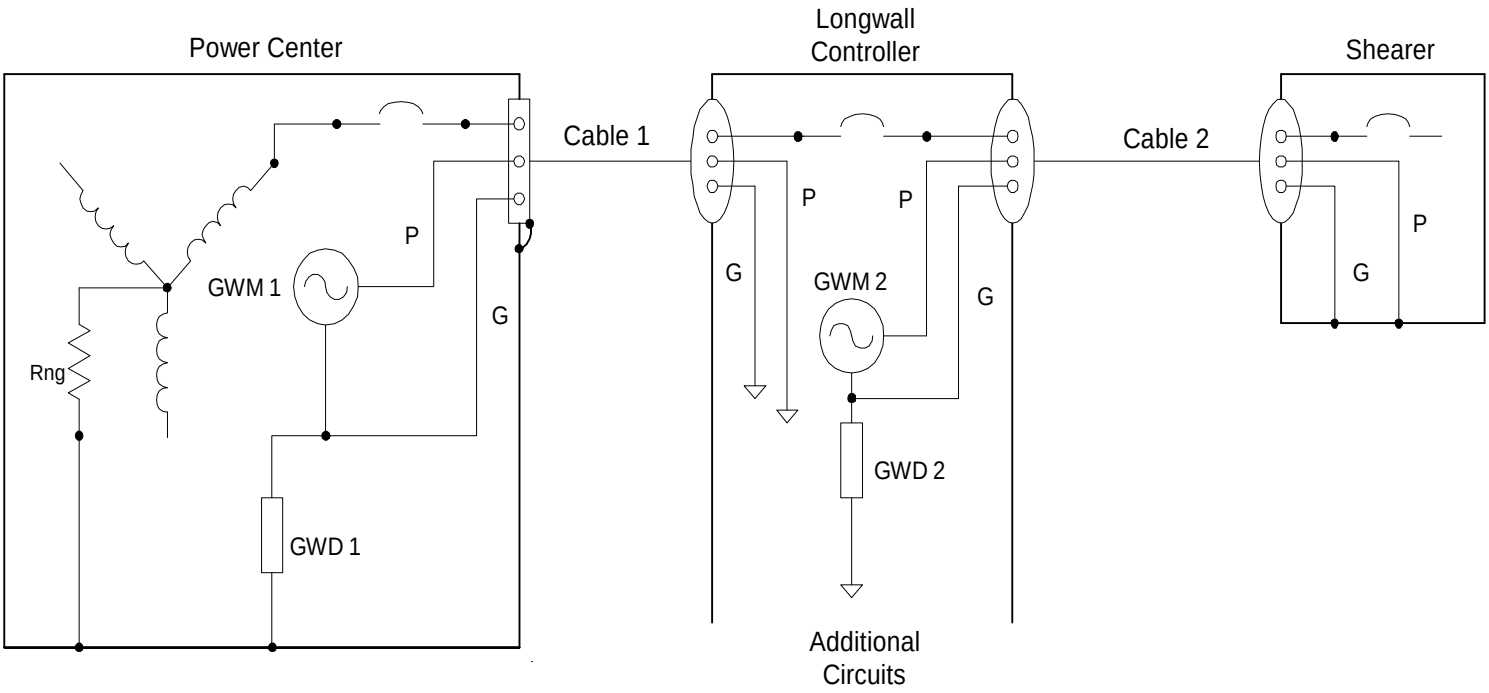
Pilot-Wireless Installation
Without Parallel Paths Shown
Figure No. 2



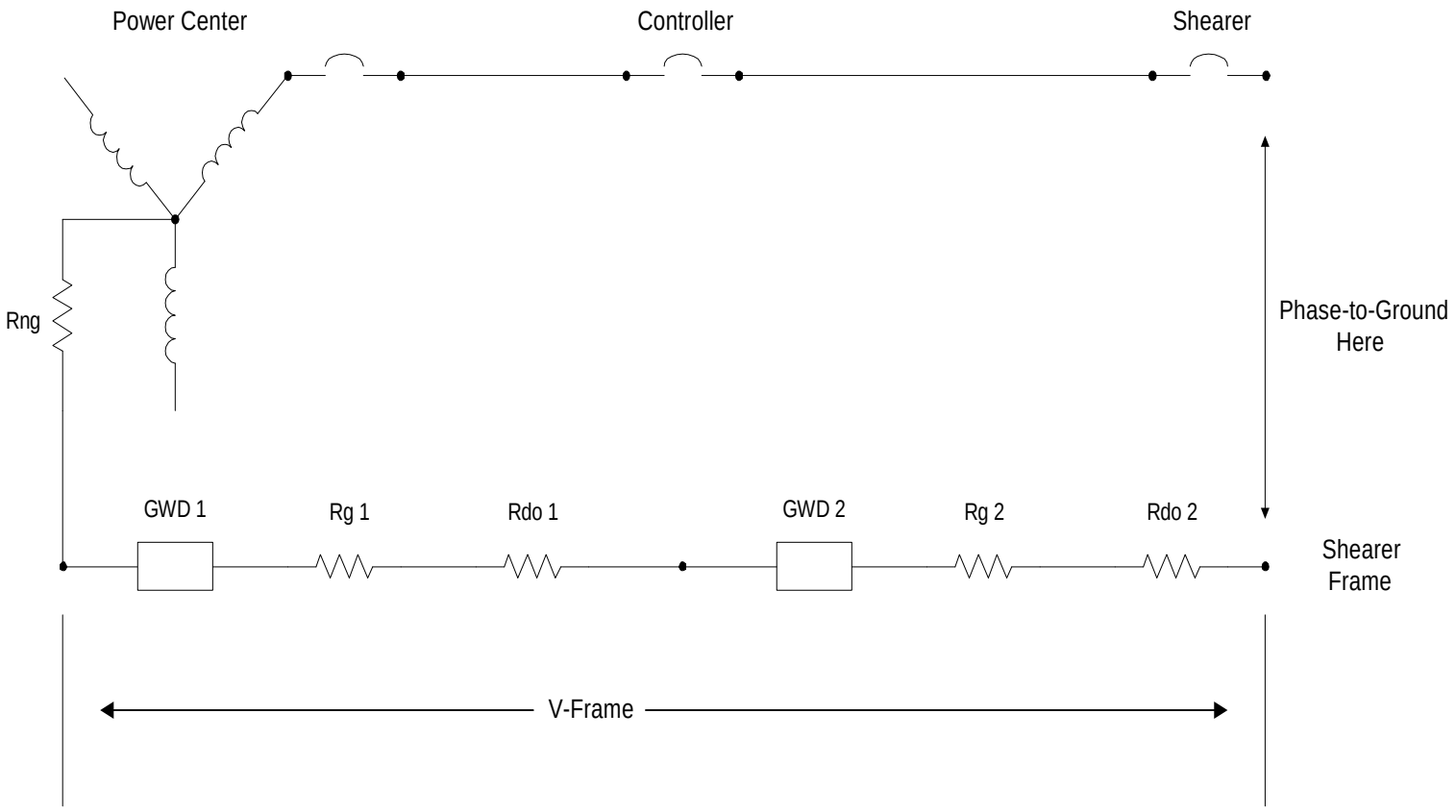
Pilot Wire Installation
With Parallel Paths Shown
Figure No. 3



Pilot-Wireless Installation
With Parallel Paths Shown
Figure No. 4



Shearer Circuit
Frame Voltage Example
Figure No. 5



Frame Voltage Schematic
Figure No. 6